Residence Time Distribution in Dynamically Changing Hydrologic Systems

Jesus D. Gomez and John L. Wilson (advisor)

Earth & Environmental Sciences, Hydrology Program, New Mexico Tech

Purpose of Study

This research will explore the effect that spatial and temporal variability in climate and weather have on residence time distributions (RTDs) for hydrologic systems. Traditionally, the dynamic response, induced by spatial and temporal variability of weather and climatic forcings on hydrologic systems, is ignored, and modeled and observed residence times are evaluated as if the flow was in steady state. Regional groundwater systems (RGSs) and stream hyporheic zones (HZs) are examples of hydrologic systems driven by forcings varying at several time scales, such as daily, seasonal, interannual, decadal and longer.

Hydrologic systems are characterized by flow paths and RTDs. Residence times vary in space, with positions further along flow paths exhibiting older ages. If the hydrologic flow system is in steady state, the flow paths do not change in time, and water present at a given point has a stable residence time distribution. But hydrologic flow paths and residence times can change dynamically with weather and climate temporal variability.

Study Underway

The study will use numerical finite-element flow and transport simulations to explore the effect of spatial and temporal variability in climate and weather forcings on the RTDs for regional groundwater systems and hyporheic zones. This research is related to a previously funded NM WRRI student grant that led to several publications in this area (Cardenas, 2007, 2008; Cardenas et al., 2008).

Benefits

Study results could provide a mechanistic explanation for the fractal behavior observed in the long-term chemistry of the water contributing to streams. Also, it has applications on groundwater age, groundwater basin chemical evolution, groundwater contamination, stream hyporheic zone, aquatic chemistry and ecology, and stream contaminant transport and regeneration.

Jesus rafting on the Chama river.

Jesus was born in Medellin, Colombia and in 2005 received a B.S. degree in civil engineering from the National University of Colombia at Medellín. Upon graduation, he moved to New Mexico Tech to begin working on an M.S. in hydrology with Dr. Jan Hendrickx. Currently, he is working on a Ph.D. in hydrology under the guidance of Dr. John L. Wilson.